that acquired either Channel A or B, which conveys 30 MHz of bandwidth, and a 19.6 percent share. This "analog handicap" thus has a relatively large impact on the respective shares of the rival firms.

A cellular operator that acquired a license for 10 MHz of bandwidth could be permitted to acquire modest amounts of additional capacity without violating current antitrust agency enforcement standards. For example, if a cellular company acquired a license for another 5 MHz, the HHI would rise by only 92 points, from 1484 to 1576. Even if both of the cellular carriers had licenses to use 35 MHz, the addition of a license for 5 MHz by either firm (bringing its total to 40 MHz), would not trigger Guidelines review because the change in the HHI is less than 100 (in a moderately concentrated industry). [See Tables 5A and 5B.]

Initial Distribution of Bandwidth - Highly Concentrated. In light of the Commission's pending plan for the allocation of spectrum for PCS services, there is a very large number of possible distributions of licenses and consequent market shares. Evaluation of the change in concentration that would result from an acquisition that occurred after the initial assignments depends on which initial distribution eventuates. For some of these distributions, a specific transaction may have little if any competitive significance, while from other initial states the market share and concentration effects may be quite large.

The Commission's plan for assigning the PCS spectrum could result in relatively high initial levels of concentration. Some firms may hold licenses for up to 40 MHz (current cellular operators are limited to 35 MHz); 40 MHz devoted to digital technologies would yield a market share of about 26 percent of effective capacity. In Table 6 we present *pro forma* HHI calculations showing the "worst case," or most highly concentrated, market structure that could

occur under the Commission's plan. This market structure would have two non-cellular firms, each holding licenses for 40 MHz, the two cellular operators each with licenses for 35 MHz, and a fifth firm with a license for 20 MHz.[58] This distribution of firm sizes results in a market structure in which two new PCS suppliers have shares of about 26 percent, the incumbent cellular companies have shares of 17.4 percent each, and the HHI is 2136.

Under the Merger Guidelines, such a market would be considered highly concentrated. Even in such an industry, where there are only five firms, however, further acquisitions may be permitted, depending on the effect of the transactions on the HHI, as well as on other factors. Our analysis shows that many possible acquisitions by cellular operators of licenses for capacity beyond 35 MHz would not violate the Merger Guidelines. Indeed, many possible transfers of capacity would actually reduce market concentration. For example, Table 7 reproduces the most highly concentrated market structure possible, and evaluates the HHI implications of the acquisition of a license for 5 MHz by one of the cellular companies (increasing its assignment to 40 MHz) from the firm that initially held a license for 20 MHz. In this setting, the cellular firm would still have smaller share than the two new PCS competitors (20.7 percent versus 26.1 percent), and the HHI would rise by only 50 points. Under the Merger Guidelines, this transaction would only barely trigger an investigation, and might well be permitted after other market factors were considered.

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[58]It seems unlikely that such a concentrated structure would actually occur, at least at the time of the initial auction. For this structure to occur, each of the firm's acquiring Channels A and B (30 MHz in a MTA) must also acquire a 10 MHz channel in each of the BTAs within the MTA, and each cellular operator must acquire one of the 10 MHz allocations in each BTA within a MTA, which is also the same as its operating region. Any other initial distribution of the PCS spectrum would result in a lower HHI.

The contrast is more pronounced for another possible transfer. From the same initial distribution of capacity, assume that one of the cellular operators acquired a license for 5 MHz from a firm that initially held 40 MHz. In this case, the HHI actually falls by 35, from 2136 to 2101. [See Table 8.] The reduction in the HHI resulting from the decrease in the share of the selling firm is larger than the increase in the HHI that accompanies the cellular operator's acquisition of new capacity.

The End of the Analog Handicap and the Entry of New Competitors. At some point in the future, current cellular operators will be freed of the obligation to continue analog services. At that time, they will be able to offer all-digital services on comparable terms to the new entrants. The end of the analog handicap would tend to increase the shares of the cellular companies. Despite these increased shares for two of the larger firms, the HHI for the industry remains essentially unchanged. For example, in Table 9 we reproduce the shares and HHI from Table 3, and compare them to the HHI after the elimination of the analog handicap. The HHI changes from 1342 (With the Analog Handicap) to 1332 (without the analog handicap).[59]

Moreover, during the period in which the analog handicap will disappear, we also expect new firms to enter. As discussed above, we expect a significant amount of new capacity to be available from, for example, the consolidation and digitization of SMR carriers' capacity. If by the time the analog handicap is eliminated, two new firms, each having 5 MHz of capacity, were

[59]Although the shares and HHI contributions of the cellular firms increase, the shares and HHI contributions of each of the other, non-cellular firms declines because of the increase in industry capacity resulting from the elimination of the analog handicap.

to have entered, the HHIs would be lower than those presented above.[60] In Table 10, we have added firms each with 5 MHz of capacity to the distribution of firms in Table 9 (Without the Analog Handicap). The addition of these firms causes the HHI to fall from 1332 to 1204.

In more highly concentrated settings, the addition of 10 MHz of capacity, held by either one or two firms, has an even larger impact on the HHI. In Table 11A we assume that the analog handicap has ended, and one firm with 10 MHz of capacity has been added to the initial distribution of five firms shown in Table 6. In this setting, the HHI falls from 2093 (the HHI Without the Analog Handicap) to 1898. Beginning from this allocation with 40 MHz, an acquisition by one of the cellular firms of a license for 5 MHz from a firm with a license for 40 MHz would leave the HHI unchanged. If one of the cellular operators were to acquire a license for 5 MHz from the smallest firm, the HHI would increase by 93 points to 1991 [Table 11B]. Note, however, that even if this were to occur, the HHI would remain below the level that had prevailed prior to new entry when the analog handicap was present. [Compare Table 7.][61]

The CTIA Proposal

In its Petition for Reconsideration, CTIA proposes a different assignment of bandwidth in the PCS auction than that specified in the Second Report and Order. Specifically, CTIA

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[60]We have assumed that only 10 MHz of capacity would be available for mobile services from the spectrum available to SMR operators. However, as much as 19 MHz may be available and could be consolidated. Thus, our assumption that only 10 MHz are included in the share calculations is conservative.

[61]Note also that, to the extent that the restriction on the cellular operators' right to acquire licenses for additional bandwidth is predicated on its "first mover" or incumbency advantage, by the time the analog handicap has been eliminated the new PCS firms likely will be established, viable competitors. If that occurs, there may no longer be any reason to limit or restrict the now-old cellular carriers. Indeed, such a limitation on the right to transfer ownership might unnecessarily lead to an inefficient allocation or use of the PCS spectrum. Thus, the rationale for placing limits on cellular operators may erode with time as new competitors become established.

proposes that the FCC award four 20 MHz and four 10 MHz licenses. This distribution of bandwidth would result in lower market concentration than the assignments currently contemplated. Table 12 presents share and HHI calculations for the spectrum assignment proposed by CTIA. The table includes calculations that both reflect and ignore the analog handicap, and assumes that: (1) incumbent cellular operators do not secure a new license; and (2) each license is acquired by an independent firm. Under these assumptions, the initial HHI with the analog handicap is 1087, and it is 1125 without the analog handicap. The HHIs resulting from the initial distribution anticipated by the FCC are presented in Table 9. In each case (with and without the analog handicap), the HHI falls by more than 200 points. With the analog handicap, the HHI falls from 1342 to 1087; without the analog handicap, the HHI falls from 1332 to 1125.

Computing Market Shares Within a Geographic Market

The computations presented above are "worst case" estimates of HHIs within a mobile telecommunications services market. The calculations assumed that each firm with a spectrum assignment served all customers within the geographic market. In fact, this will often not be the case. Because licenses may be awarded for both broad and narrow regions, and because price discrimination is barred by Section 202(a) of the Communications Act, many providers are likely to offer service to only a portion of customers within a broader market. For example, assume that a MTA is a relevant geographic market for mobile telecommunications services. Some firms will likely only serve one or more BTAs within the broader MTA-wide market. One firm will have an assignment of 20 MHz within some BTA, and (ignoring the analog handicap) a corresponding 11.8 percent bandwidth share in that BTA [20 MHz ÷ 170 MHz =

.118] If that licensee, however, operates only within that BTA, its ability to serve customers in the entire geographic market (which in this example is the MTA) is determined both by its bandwidth and by the proportion of the population (or potential customers) in that BTA. Thus, if a firm has an 11.8 percent share of the bandwidth in a BTA that contains 20 percent of the population within the overall MTA market, then its share of the market is only 2.4 percent — the portion of the population in the BTA multiplied by the share of capacity within the BTA [.118 x .2 = .024 percent].

This issue of the proper computation of a firm's share within a geographic market bears directly on the Commission's proposed limitations on the right of cellular operators to secure MTA-wide licenses in the upcoming PCS auction. The Second Report and Order bars a cellular operator from securing a MTA-wide license for 30 MHz of bandwidth if that operator already serves more than 10 percent of the population within the MTA.

Assuming again that the MTA is a relevant geographic market, using the method described above, we may estimate the share that a cellular operator would hold if it were assigned a 30 MHz, MTA-wide license. The cellular operator's market share in the MTA would be composed of two parts, its share represented by the MTA-wide, 30 MHz license, and its share within the BTA(or BTAs) where it operates weighted by the proportion of MTA population in the narrower area (areas). Assume, for example, that the operator served, under its cellular license, only 10 percent of the population within a MTA, and that it then secured a 30 MHz allocation of spectrum in the PCS section. The first component of its share would simply be the share attributable to the 30 MHz that may be used to serve the entire MTA, or 17.6 percent [30 MHz ÷ 170 MHz = .176].

The second component of its market share, attributable to its cellular operation, depends on the portion of the population served within the MTA. Wherever such a firm currently operated, it would have assigned bandwidth of 25 MHz, or 14.7 percent of the bandwidth in that (limited) area [25 MHz ÷ 170 MHz = .147]. Its share of the capacity to serve customers within the broader market (the MTA) represented by this cellular license would be only 1.47 percent [.147 x .10 = .0147], reflecting the fact that the firm serves only 10 percent of the population under that cellular license. The share of that firm within the total market is, thus, the sum of 17.6 percent (its MTA-wide share) and 1.47 percent (the share attributable to its cellular operation), for a total share of the market of about 19.1 percent. The cellular operator's share within the market increases as the portion of the population served with the cellular license rises. For example, if the cellular operator served 25 percent of the population in the MTA, and it was allowed to acquire the rights to a 30 MHz license, it would have a marketwide share of 21.3 percent.

The rule barring a cellular operator from acquiring the rights to a MTA-wide, 30 MHz license, if it currently serves 10 percent of the population, limits its market share within the MTA to no more than 17.6 percent. The Second Report and Order, however, allows new, non-cellular operators to acquire as much as 40 MHz, or 23.5 percent of the capacity within a MTA. Thus, the limit imposed on cellular companies results in a substantial difference between the positions that may be achieved by the two classes of competitors. As shown above, the share of the cellular operator would rise toward the 23.5 percent ceiling that is allowed for other firms as the proportion of the population served under the cellular license increases. The portion of the population within the MTA served under the cellular license would have to rise to just over

40 percent before its share of the capacity to serve customers within the market reached 23.5 percent.[62]

These examples have assumed that: (1) a cellular firm's territory was the same as a BTA; (2) the cellular firm's operations are limited to the MTA, i.e., that its operations did not "spill out" of the MTA; and (3) the MTA is a relevant geographic market. However, the methodology presented above is also applicable if the MTA is a market and the cellular operator's territory is wholly within that market.[63] If the cellular company's territory extends beyond the MTA, and the relevant geographic market is broader than a MTA, then the methodology is overly conservative. Where the geographic market is larger than a MTA, and the cellular operator's territory extends outside the MTA (but remains within some broader market), the formula described above, by limiting attention to only a portion of the total market, will systematically overstate the share of the cellular operator. This implies that when the geographic market is larger than a MTA, a cellular company could serve even more than 40 percent of the population within the MTA, and still not attain a share of 23.5 percent.

VI. Limitations on Collusive Behavior

Under the Merger Guidelines, the number and size distribution of firms in a market are important initial indicators of the likelihood of competitive behavior. This follows from a belief

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[62][Share from MTA Allocation] + [(BTA Share)(BTA Portion of Population)] = Total MTA-Wide Share. Assume that 1) the cellular operator acquires a 30 MHz MTA allocation (17.6 percent); 2) holds a 25 MHz allocation within some BTA (14.7 percent); and 3) may hold a share of no more than 23.5 percent of the MTA's capacity. One may solve the equation for the maximum proportion of the MTA's population that can be served by the cellular operator within its BTA. .176 + .147(BTA Portion of Population) = .235. BTA Portion of Population = .401.

[63]If the Cellular Geographic Service Area (CGSA) is different from a BTA, but lies entirely within a MTA, BTA would be replaced by CGSA in the formula in footnote 62.

that market participants can more easily coordinate their behavior when they are few in number. Similarly, the costs of monitoring the behavior of others, and enforcing any collusive arrangement by punishing "cheaters," are lower when there are few industry participants.

The opening of the 2 GHz band for the provision of Personal Communications Services, and the developments in the SMR band described above, will contribute to a reduction in concentration in the provision of mobile telecommunications services. However, in this as in other markets, it is necessary to look beyond measured concentration in judging the extent of market competitiveness.

Many factors that are present in the mobile telecommunications market make concerns about anticompetitive behavior even less important than might be suggested by the number of firms and their respective market shares. These factors, which influence the strategies each firm pursues, and thus affect the extent of market competitiveness, are: (A) the rapid pace of technological progress in the industry; (B) the rapid growth in the demand for mobile services; (C) the wide array of service offerings; (D) the structure of costs; and (E) an expanding fringe.

Factors that make collusion more difficult and affect the ease with which deviations from a collusive outcome can be detected and punished help to determine how close to the competitive outcome the mobile telecommunications industry's performance will be.[64] As a result, they should be taken into account by the Commission when it considers whether to place limitations on the share of the mobile services market that can be served by any firm or firms.

Technological Progress. The rapid technological change in the provision of mobile telecommunications is manifested in a high degree of variability in the services offered and the

[64]See G.J. Stigler, "A Theory of Oligopoly," Journal of Political Economy 74 (1964), pp. 44-61.

prices of those services. As new services are offered, a collusive agreement is difficult to maintain because the price of each new service must be integrated into the existing price structure.[65] When firms are continually modifying, improving, and adding new products and services, reaching agreement on a collusive price is itself problematic. Moreover, as providers adopt new technologies, the introduction of new service packages offers opportunities to "cheat" on any putative anticompetitive agreement without provoking the "punishment" that might otherwise occur, in part because it is difficult for rivals to determine the appropriate price for a new service. As a result, new services are likely to be offered at more competitive prices, because it is easier to deviate from a collusive agreement when products are changing.[66]

In addition, rivals may perceive that the new services are being offered at prices that are "too low" because they do not know what those prices should be.[67] If technology and service offerings were stable, agreements might eventually be reached on appropriate pricing, but such agreements are difficult to effect when technology is changing continuously, as in the mobile telecommunications services market. "Misunderstandings," or the belief that a rival is cutting price in violation of a collusive agreement, will undermine an individual firm's confidence in the stability of an agreement, and may result in further price cuts.

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[65]R.A. Posner, Antitrust Law: An Economic Perspective (Chicago, IL: The University of Chicago Press, 1976), pp. 59-60.

[66]F.M. Scherer and David Ross, op. cit., p. 285, observe that "the more rapidly producers' cost functions are altered through technical change and the more unevenly those changes are diffused throughout the industry, the more likely there will be conflict regarding pricing choices."

[67]One factor that contributes to this difficulty is that firms may have different costs for new services, yet each firm is unable to gain information on the costs of its rivals. Thus, a low price might be treated as a deviation from an agreement when it only reflects the low costs of its supplier.

Market Growth. The rapid rate of technological innovation not only hinders the smooth functioning of a collusive pricing agreement in the mobile services market, but it also results in rapid market growth. Such growth may weaken the incentive for firms to participate in collusive agreements because, when markets are growing rapidly, demand may become more inelastic, so the gains from deviating from a collusive price are greater.[68] If the probability of detection is unchanged and the gains from deviation are increased, firms are more likely to price aggressively, to the benefit of consumers.

The mobile telecommunications services market, even when confined to mobile telephone service, has exhibited extraordinary growth during its relatively brief history. The number of cellular subscribers has increased from about 1 million in 1984 to more than 15 million in 1993. In these circumstances, there are potentially large gains to be made from attracting a large proportion of new subscribers.[69]

The importance of this factor is further enhanced if there are significant learning economies. By keeping its prices low, a firm can increase production and achieve cost savings more rapidly as it moves down its learning curve.[70] Economic models that incorporate learning economies predict that industry performance will be better if, instead of a large number of very small firms, the industry consists of a few large, long-run, profit-maximizing firms. The predictions of such models are consistent with past developments in the mobile telecommunications industry.

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[68]J.J. Rotemberg and G. Saloner, "A Supergame-Theoretic Model of Price Wars During Booms," American Economic Review 76 (1986), pp. 390-407.

[69]This may be offset to some degree by the relatively high rate of "churn" among subscribers.

[70]A.M. Spence, "The Learning Curve and Competition," The Bell Journal of Economics 12 (1981), pp. 49-70.

Service Heterogeneity. A third characteristic of the mobile services market that weakens industry cohesion, and thus the ability of firms to raise prices, is the heterogeneity of product offerings.[71] The absence of an obvious basis for comparing service prices increases the cost of monitoring and punishing deviations from any collusive agreement.[72] With the introduction of PCS, product heterogeneity will increase. As a result, the cost of monitoring a collusive agreement also will increase because price changes that reflect differences in service quality will be difficult to distinguish from those that undercut a tacit agreement.

The Structure of Costs. An important factor that affects the ability of firms to coordinate their pricing decisions is the structure of their costs. In particular, collusive behavior is generally believed to be less likely in industries, like mobile telecommunications service, where a significant portion of a firm's costs must be incurred regardless of the level of its output, i.e., when fixed costs are high relative to variable costs. In such circumstances, the incentive of a firm to reduce prices if demand falls short of capacity is much greater than it is in situations in which output reductions result in larger reductions in costs. As Scherer and Ross note:

> There is reason to believe that industries characterized by high overhead costs are particularly susceptible to pricing discipline breakdowns when a cyclical or secular decline in demand forces member firms to operate well below designed plant capacity.[73]

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[71]This is distinct from the rapidity with which service offerings change, which was discussed above. Both factors are present here.

[72]K.W. Clarkson, and R.L. Miller, Industrial Organization: Theory, Evidence, and Public Policy (New York, NY: McGraw-Hill Book Company, 1982), pp. 335-336.

[73]Op. cit., p. 286.

They go on to observe that:

> When demand falls below levels that will sustain capacity output, the profit-maximizing enterprise with high fixed costs cuts prices more sharply and suffers more severe erosion of profits than a similarly inclined firm with low fixed costs.[74]

The reason for this difference in behavior is that a firm with large fixed costs and substantial excess capacity will experience significant losses because so few of its costs decline when its output falls. In turn, the firm has strong incentives to increase its output by cutting prices because the change in output can be accomplished at relatively little additional cost. In such situations, pricing discipline among firms is difficult to maintain.

Although the demand for mobile telecommunications services is expected to grow rapidly, it is also the case that much investment is both expected, and will have to be made, in anticipation of that demand growth. There are thus likely to be many situations or time periods in which some firms have substantial excess capacity, i.e., they will be able to increase their output while incurring relatively few additional costs. That is precisely the situation in which economic analysis indicates that vigorous price competition is most likely, and that collusion is unlikely.[75]

An Expanding Fringe and Future Entry. The calculations we have carried out above show the importance of the expanding "fringe" in the mobile telecommunications services market. The increased ability of SMR operators to offer a wider variety of mobile telecommunications services argues for including them in the market, and the calculations reported above reveal how much the inclusion of two significant SMR providers reduces measured concentration. Some

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[74]Op. cit., p. 288.

[75]Put differently, what drives competition in a high fixed cost-low variable cost industry is a discrepancy between capacity and demand, and that discrepancy can result either from a decline in demand or from rapidly growing capacity.

additional entry can probably be expected from this source, which would reduce concentration still further.

In addition, entry is likely from the large number of planned mobile satellite ventures, many of which will target the United States market.[76] The proposed entrants are supported by major telecommunications firms, including Motorola, Sprint, GTE, Comsat, Hughes, McCaw, and TRW. This forthcoming entry further reduces the significance of existing market shares as measures of the future competitiveness of the mobile services market.[77]

In sum, there is a variety of important market conditions that inhibit the ability of firms offering mobile telecommunications services from either reaching or enforcing a collusive agreement. When such factors are present, even transactions that increase concentration beyond certain trigger levels, like those in the Merger Guidelines, will likely not threaten to reduce competition.

Efficiencies From Combining Cellular and PCS

While anticompetitive conduct from allowing incumbent cellular operators to acquire capacity in the 2 GHz band are unlikely, there are efficiency advantages from permitting them to do so. For example, an FCC Office of Plans and Policy Working Paper[78] finds that there are strong economies of scope between cellular services and PCS that result from the Operations, Administration, and Maintenance Services, Switching, and Handsets components of the cost

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[76]S. Sugawara, "Battle in the Skies" (Washington Post, "Washington Business," October 18, 1993, pp. 1 and 14-15) describes nine such systems.

[77]¶ 1.521 of the Merger Guidelines recognizes the importance of changing market conditions. It notes that "recent or ongoing changes in the market may indicate that the current market share of a particular firm either understates or overstates the firm's future competitive significance."

[78]D.P. Reed, op. cit.

model it analyzes. The results, which indicate that the there are costs savings of about $65 per subscriber per year from combining cellular and PCS operations (assuming a 10 percent penetration of PCS and a 25 MHz spectrum allocation), are similar to the economies of scope found from combining cellular with either telephone or cable television operations.

VII. Policy Implications

On the basis of the analyses above, we reach several specific conclusions. First, the limitation on the amount of bandwidth that may be licensed to a cellular operator could reasonably be relaxed in many areas without the risk of anticompetitive harm. Even if BTAs were meaningful geographic markets, we do not believe that allowing cellular operators to acquire and hold more than 35 MHz of bandwidth would necessarily harm competition. In many market settings, such acquisitions would not even trigger significant investigation under the Merger Guidelines. Second, because the geographic market for mobile telecommunications services will often be broader than a BTA, limiting the ability of a cellular carrier to bid for licenses for 10 MHz of capacity in areas where it already serves only 10 percent of the populations may, on competition grounds, be too restrictive.

The 35 MHz Limit

Given our analysis of shares and concentration in the market for mobile telecommunications services, even on purely structural grounds, allowing the cellular companies to acquire some additional bandwidth (5 MHz, for example) beyond the amount they are permitted to acquire in the PCS auctions would not necessarily trigger serious antitrust review. Beginning from a market structure for mobile services that is moderately concentrated, one can

identify potential acquisitions by cellular carriers that would not violate the current Merger Guidelines standards. Other potential transactions involving added capacity for cellular operators might trigger antitrust review, but many of those transactions do not significantly exceed Guidelines standards, and even they might be approved after consideration of other factors.

Current FCC rules allow the formation of quite concentrated market structures, with as few as five firms. Even in this setting, however, the acquisition of added capacity by one of the existing cellular operators would not necessarily violate the structural criteria of the Merger Guidelines. Indeed, there are plausible scenarios, involving the exchange of capacity between a large PCS firm and a cellular operator, that would leave concentration unchanged, or, actually reduce it.

We conclude that, on purely structural grounds, limiting licenses for cellular operators to 35 MHz would be too rigid. Anticompetitive behavior by a single firm, where the largest firm is limited to no more than 40 MHz of bandwidth, is unlikely. Moreover, even when concentration is very high, collusion and other forms of anticompetitive behavior in the market for mobile telecommunications services are effectively inhibited by many non-structural factors.

Limits on Bidding for MTA Licenses

If a cellular company serves more than 10 percent of the population in any MTA, it may not bid for either of the 30 MHz, MTA-wide licenses. It is instead, limited to bidding for one 10 MHz license in each BTA in its current service territories. The basis for this limitation must be either a belief that relatively small areas, such as BTAs, constitute relevant geographic markets, or that allowing a cellular firm to hold, say, 30 MHz across an entire MTA and 55

MHz in some limited area (with more than 10 percent of the population) would threaten competition.

Absent price discrimination, BTAs are not generally relevant geographic markets; actual antitrust markets encompass broader regions. As we discussed in the section on market definition, as long as the firms cannot discriminate in pricing to subscribers in different BTAs, there should be no concern that a cellular carrier with an allocation of 55 MHz in a limited portion of a larger market could exercise market power because such a firm, either acting alone or in concert with other firms, would not be able profitably to raise prices. So long as cellular operators currently serve less than 40 percent of the population in a MTA that is also a market, allowing them to acquire a 30 MHz license would result in a share that is smaller than that of a non-cellular supplier with licenses totaling 40 MHz.

Table 3

HHI Calculations

Digital : Analog / 6 : 1

Cellular Operators Bandwidth Devoted to Analog : 10 MHz

Firms	Bandwidth	Effective Capacity*	Market Share	HHI Contribution
Cellular 1	25	100	10.9%	118
Cellular 2	25	100	10.9%	118
3	30	180	19.6%	383
4	30	180	19.6%	383
5	20	120	13.0%	170
6	10	60	6.5%	43
7	10	60	6.5%	43
8	10	60	6.5%	43
9	10	60	6.5%	43
Totals	170	920		1,342

* Effective Capacity is defined as bandwidth devoted to digital multiplied by the ratio of digital's advantage over analog plus bandwidth devoted to analog.

Source: FCC, Second Report and Order ; Charles River Associates.

Table 4

HHI Calculations

Digital : Analog / 6 : 1

Cellular Operators Bandwidth Devoted to Analog : 10 MHz

Firms	Initial Bandwidth	Effective Capacity*	Market Share	HHI Contribution	Acquired Bandwidth	Final Bandwidth	Effective Capacity*	Market Share	HHI Contribution
Cellular 1	25	100	10.9%	118	10	35	160	17.4%	302
Cellular 2	25	100	10.9%	118		25	100	10.9%	118
3	30	180	19.6%	383		30	180	19.6%	383
4	30	180	19.6%	383		30	180	19.6%	383
5	20	120	13.0%	170		20	120	13.0%	170
6	10	60	6.5%	43		10	60	6.5%	43
7	10	60	6.5%	43		10	60	6.5%	43
8	10	60	6.5%	43		10	60	6.5%	43
9	10	60	6.5%	43	-10	0	0	0.0%	0
Totals	170	920		1,342		170	920		1,484

Herfindahl-Hirschman Analysis		
	Initial HHI	1,342
	Change	142
	Final HHI	1,484

* Effective Capacity is defined as bandwidth devoted to digital multiplied by the ratio of digital's advantage over analog plus bandwidth devoted to analog.

Source: FCC, Second Report and Order ; Charles River Associates.

Table 5A

HHI Calculations

Digital : Analog / 6 : 1

Cellular Operators Bandwidth Devoted to Analog : 10 MHz

Firms	Initial Bandwidth	Effective Capacity*	Market Share	HHI Contribution	Acquired Bandwidth	Final Bandwidth	Effective Capacity*	Market Share	HHI Contribution
Cellular 1	35	160	17.4%	302	5	40	190	20.7%	427
Cellular 2	25	100	10.9%	118		25	100	10.9%	118
3	30	180	19.6%	383		30	180	19.6%	383
4	30	180	19.6%	383		30	180	19.6%	383
5	20	120	13.0%	170		20	120	13.0%	170
6	10	60	6.5%	43		10	60	6.5%	43
7	10	60	6.5%	43		10	60	6.5%	43
8	10	60	6.5%	43	-5	5	30	3.3%	11
Totals	170	920		1,484		170	920		1,576

Herfindahl-Hirschman Analysis		
	Initial HHI	1,484
	Change	92
	Final HHI	1,576

* Effective Capacity is defined as bandwidth devoted to digital multiplied by the ratio of digital's advantage over analog plus bandwidth devoted to analog.

Source: FCC, Second Report and Order ; Charles River Associates.

Table 5B

HHI Calculations

Digital : Analog / 6 : 1

Cellular Operators Bandwidth Devoted to Analog : 10 MHz

Firms	Initial Bandwidth	Effective Capacity*	Market Share	HHI Contribution	Acquired Bandwidth	Final Bandwidth	Effective Capacity*	Market Share	HHI Contribution
Cellular 1	35	160	17.4%	302	5	40	190	20.7%	427
Cellular 2	35	160	17.4%	302		35	160	17.4%	302
3	30	180	19.6%	383		30	180	19.6%	383
4	30	180	19.6%	383		30	180	19.6%	383
5	20	120	13.0%	170		20	120	13.0%	170
6	10	60	6.5%	43		10	60	6.5%	43
7	10	60	6.5%	43	-5	5	30	3.3%	11
Totals	170	920		1,626		170	920		1,718

Herfindahl-Hirschman Analysis		
	Initial HHI	1,626
	Change	92
	Final HHI	1,718

* Effective Capacity is defined as bandwidth devoted to digital multiplied by the ratio of digital's advantage over analog plus bandwidth devoted to analog.

Source: FCC, Second Report and Order ; Charles River Associates.

Table 6

HHI Calculations

Digital : Analog / 6 : 1

Cellular Operators Bandwidth Devoted to Analog : 10 MHz

Firms	Bandwidth	Effective Capacity*	Market Share	HHI Contribution
Cellular 1	35	160	17.4%	302
Cellular 2	35	160	17.4%	302
3	40	240	26.1%	681
4	40	240	26.1%	681
5	20	120	13.0%	170
Totals	170	920		2,136

* Effective Capacity is defined as bandwidth devoted to digital multiplied by the ratio of digital's advantage over analog plus bandwidth devoted to analog.

Source: FCC, Second Report and Order ; Charles River Associates.

Table 7

HHI Calculations

Digital : Analog / 6 : 1

Cellular Operators Bandwidth Devoted to Analog : 10 MHz

Firms	Initial Bandwidth	Effective Capacity*	Market Share	HHI Contribution	Acquired Bandwidth	Final Bandwidth	Effective Capacity*	Market Share	HHI Contribution
Cellular 1	35	160	17.4%	302	5	40	190	20.7%	427
Cellular 2	35	160	17.4%	302		35	160	17.4%	302
3	40	240	26.1%	681		40	240	26.1%	681
4	40	240	26.1%	681		40	240	26.1%	681
5	20	120	13.0%	170	-5	15	90	9.8%	96
Totals	170	920		2,136		170	920		2,186

Herfindahl-Hirschman Analysis

Initial HHI	2,136
Change	50
Final HHI	2,186

* Effective Capacity is defined as bandwidth devoted to digital multiplied by the ratio of digital's advantage over analog plus bandwidth devoted to analog.

Source: FCC, Second Report and Order ; Charles River Associates.

Table 8

HHI Calculations

Digital : Analog / 6 : 1

Cellular Operators Bandwidth Devoted to Analog : 10 MHz

Firms	Initial Bandwidth	Effective Capacity*	Market Share	HHI Contribution	Acquired Bandwidth	Final Bandwidth	Effective Capacity*	Market Share	HHI Contribution
Cellular 1	35	160	17.4%	302	5	40	190	20.7%	427
Cellular 2	35	160	17.4%	302		35	160	17.4%	302
3	40	240	26.1%	681	-5	35	210	22.8%	521
4	40	240	26.1%	681		40	240	26.1%	681
5	20	120	13.0%	170		20	120	13.0%	170
Totals	170	920		2,136		170	920		2,101

Herfindahl-Hirschman Analysis		
	Initial HHI	2,136
	Change	-35
	Final HHI	2,101

* Effective Capacity is defined as bandwidth devoted to digital multiplied by the ratio of digital's advantage over analog plus bandwidth devoted to analog.

Source: FCC, Second Report and Order ; Charles River Associates.

Table 9

HHI Calculations

Digital : Analog / 6 : 1

Firms	With Analog Handicap (10MHz)				Without Analog Handicap			
	Bandwidth	Effective Capacity*	Market Share	HHI Contribution	Bandwidth	Effective Capacity*	Market Share	HHI Contribution
Cellular 1	25	100	10.9%	118	25	150	14.7%	216
Cellular 2	25	100	10.9%	118	25	150	14.7%	216
3	30	180	19.6%	383	30	180	17.6%	311
4	30	180	19.6%	383	30	180	17.6%	311
5	20	120	13.0%	170	20	120	11.8%	138
6	10	60	6.5%	43	10	60	5.9%	35
7	10	60	6.5%	43	10	60	5.9%	35
8	10	60	6.5%	43	10	60	5.9%	35
9	10	60	6.5%	43	10	60	5.9%	35
Totals	170	920		1,342	170	1,020		1,332
Herfindahl-Hirschman Analysis				1,342				1,332

* Effective Capacity is defined as bandwidth devoted to digital multiplied by the ratio of digital's advantage over analog plus bandwidth devoted to analog.

Source: FCC, Second Report and Order ; Charles River Associates.